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SEX DIFFERENTIALS IN STUDENTS' ACHIEVEMENT AND INTEREST IN TRIGONOMETRY USING INQUIRY TEACHING METHOD (ITM)

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Abstract

The study determined differentials in students' achievement and interest in trigonometry using Inquiry Teaching Method (ITM) (ITM). The study was guided by two (2) research questions and four (4) research hypotheses. The design of this study was non-equivalent control quasi-experimental research. The sample size of the study was four hundred and fifty-six (456) Senior Secondary School Students One (SSS 1) in the three (3) sampled coeducational secondary schools in Enugu Education zone. Hence, the researcher sampled two hundred and forty-seven (247) male Senior Secondary School Students One (SSS 1) and two hundred and nine (209) female Senior Secondary School Students One (SSS 1). Trigonometry Achievement Test (TAT) and Trigonometry Interest Scale (TIS) were the instruments that were used for data collection, which underwent face validation only and were reliable with the K-R20 coefficient of 0.78 and Cronbach Alpha of 0.74 respectively. Mean ($\bar{x}$) and standard deviation (s) were used in answering the research questions. Analysis of Covariance (ANCOVA) was used in testing the research hypotheses at 0.05 alpha level. The study discovered the female students that taught trigonometry using the Inquiry Teaching Method (ITM)had the higher posttest mean achievement and interest scores than their male counterparts and the differences were significant. Secondly, the study discovered that there were significant interactions between gender of students and the methods on students' achievement and interest scores in Trigonometry. The study recommended that parents and mathematics teachers should ensure that the male students are given equal functions with their female counterparts both at home and in school to do so that it won't be difficult for the male students to transfer the knowledge learnt at home to school Mathematics (trigonometry).

Introduction

Mathematics is defined as a science of numbers, quantities, shapes and spaces (Chukwu, 2010). Mathematics is a physical science that is practically and activity oriented which uses abstract symbols, axioms and facts to deal with numbers, shapes and equally solve day to day problems (Albert, 2017). Mathematics has generally been accepted as the foundation of science and technology and it is a very important subject in school curriculum (Udousoro, 2011). According to Anibueze (2018), mathematics is a vital gateway for students to triumph over the other subjects particularly for science subjects. This is because mathematics enables students to grasp fundamental knowledge, basic skills, and basic ideas in mathematics, as well as develop students to express clearly and think systematically, so as to enable students to possess realistic and practical attitudes, and spirit of perseverance. Students learn how to deploy mathematics thinking methods to solve problems and know the world they live in.

Mathematics is a science subject that is bedeviled with a lot of controversies over gender performance (Anibueze, 2018). While some mathematics educators/scholars believed that male students achieved better and had more interest in mathematics than their female counters, others are with contrarily opinions/findings. Harbor-Peters (2001) pointed out that gender issue in mathematics has been a source of aversion. Gender has become a contemporary variable for mathematics educators and researchers because of its effect on mathematics teaching, learning, achievement and interest (Anibueze, 2018). Gender is a cultural construct that distinguishes the roles, behaviour, mental and emotional characteristics between male and female, developed by a society (Udousoro, 2011). Umoh (2003) defined gender as psychological term used in describing behaviours and attributes expected of individuals of a basis of being born as either male or female. Njoku (2013) stated that in Nigerian cultural setting, gender had strongly affected sex role, especially in choice of school subjects. Njoku (2013) pointed out that sex role stereotype and expectation had unduly influenced the attitude of males and females to many things, especially subjects in schools and in particular mathematics.

Kolawale and Ogini (2008) reported that male superiority over female counterparts in geometry aspect of mathematics was significant. According to Asiegbu (2000), mathematics has been male stereotype, especially as mathematics is regarded as abstract and difficult, and has attributes which boys are attracted to. Boys are good at handling of difficult situations. Some teachers even feel more comfortable making a boy than a girl understand mathematics. Hydea and Mertzb (2009) observed that females have reached parity with male. Asoegwu (2008) revealed that female students achieved better in mathematics when they were taught using effective modern instructional approaches. According to Ahmed (2008), the female aremore prone to express interest in mathematics than their male counterparts. In most secondary schools, especially at the mixed schools, the number of female students that passed mathematics is more than their male counterparts. This is because, since it is the female students that do domestic chores

more than their male counterparts and mathematics plays a significant role in domestic chores, so it won't be difficult for the female students to transcend their passive mathematical domestic knowledge to active mathematical classroom knowledge.

Pinder (1987) viewed that both males and females compete favorably in mathematics and stressed that it is a misconception to think that males achieve higher than females in mathematics. More so, Ukeje (1979) stressed that neither males nor females are superior in general intelligence. This suggests that both males and females have the same ability even in understanding mathematics if it is taught meaningfully. Ozomadu (2006) revealed that there was no significant difference between the mean achievement of male and female students in mathematics and there was no significant interaction of gender and teaching method. According to Bassey, Joshua and Asim (2010), if males and females are given the same opportunity in scientific inquiry, they will produce exactly the same result in mathematics. Ogunkunle (2017) established significant difference in favour of male Mathematics students and another part in favour of females. Based on these contradicting results, this study seeks to examine if there issex differentials in students' achievement and interest in trigonometry using Inquiry Teaching Method (ITM). The essence of determining the sex differential in trigonometry is because trigonometry is an important topic in the secondary school mathematics curriculum that is taught early and that links algebraic, geometric, and graphical reasoning (Vajiac& Snow, 2019). Trigonometry can serve as an important precursor to calculus as well as college/university level courses (Weber, Knott, & Evitts, 2008). It gives students good practice in employing the algebraic skills and most importantly, it benefits students' thinking processes (Gurat& Sagun, 2018).

Unfortunately, many students do not experience the richness, connections or creativity that trigonometry allows, instead they often perceive it as another memory exercise where rules and formulae must be learnt by rote, along with methods for working out problems (Umar & Ibrahim, 2018). Gurat& Sagun (2018) reported that students are having difficulties in solving trigonometry. Since students cannot get the topic, they do not have any time as the teacher moves on the next topic (Gallup, 2005). One factor that could affect the students in learning trigonometry is the instructional method used by the mathematics teacher (Andaya, 2014; Gurat& Sagun, 2018). One of the methods that the researchers want to determine its efficacy in the teaching of trigonometry is Inquiry Teaching Method (ITM). The choice of Inquiry Teaching Method (ITM) was based on the fact that among all innovative teaching methods, Inquiry Teaching Method (ITM) is the type of teaching method whose philosophy is heavily rooted in the works of some cognitive theorists like Jean Piaget, John Dewey, Vygotsky and Preire, Immanuel Kant, John Locke, among others (Kirshner, Sweller& Clark, 2006; Aniaku, 2012; Shittu, 2013; Omokaadejo, 2015).

The Inquiry Teaching Method (ITM) is a learning process which seems to increase students' level of involvement in the teaching and learning of Trigonometry. It

may also expose the students to the multiple ways of learning the concepts in Trigonometry and enable the students to pass through the sequential phases of cognition which seems to accommodate learning and cognition differences among students. Aniaku (2012) revealed that this method is a teaching method that encourages learners to apply scientific process to explore and construct meaningful knowledge and skills. Cheval and Hart (2015) classified Inquiry Teaching Method (ITM) into three (3) classes, namely: structured inquiry, guided inquiry and unguided/open inquiry. All these types of inquiry can be useful to students to learn science when taught appropriately. Hence, this study shall use the three classes of Inquiry Teaching Method (ITM) as outlined by Cheval and Hart (2015) in determining sex differentials in students' achievement and interest in trigonometry.

Purpose of the Study

The main aim of the study was to determine sex differentials in students' achievement and interest in trigonometry using Inquiry Teaching Method (ITM). Specifically, the study determined the mean;

1. Achievement scores of male and female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM).
2. Interest scores of male and female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM).

Research Questions

The following research questions guided the study

1. What are the mean achievement scores of male and female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM)?
2. What are the mean Interest scores of male and female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM)?

Research Hypotheses

The following research hypotheses were tested at 0.05 level of significance guided the study.

H0 1: There is no significant difference between the mean achievement scores of male and female students that are taught Trigonometry using Inquiry Teaching Method (ITM).

H0 2: There is no significant interaction between gender of students and the methods on students' achievement scores in Trigonometry.

H0 3: There is no significant difference between the mean interest scores of male and female students that are taught Trigonometry using Inquiry Teaching Method (ITM).

H0 4: There is no significant interaction between gender of students and the methods on students' interest scores in Trigonometry.

Methodology

The design of this study was non-equivalent control quasi-experimental research. This study was conducted in secondary schools in Enugu Education zone of Enugu State. The sample size of the study was Four hundred and fifty-six (456) Senior Secondary School Students One (SSS 1) in the three (3) sampled coeducational secondary schools in Enugu Education zone. Hence, the researcher sampled two hundred and forty-seven (247) male Senior Secondary School Students One (SSS 1) and two hundred and nine (209) female Senior Secondary School Students One (SSS 1). Trigonometry Achievement Test (TAT) and Trigonometry Interest Scale (TIS) were the instruments that were used for data collection, which underwent face validation only and were reliable with the K-R20 coefficient of 0.78 and Cronbach Alpha of 0.74 respectively. Mean ($\bar{x}$) and standard deviation (s) were used in answering the research questions. Analysis of Covariance (ANCOVA) was used in testing the research hypotheses at 0.05 alpha levels.

Results

Research Question 1: What are the mean achievement scores of male and female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM) (ITM)?

Table 1: The Mean Achievement Scores of Male and Female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM)

Gender	Number	Pretest		Post-test	
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)
Guided ITM	60	51.00	14.33	57.88	16.20
Unguided ITM	64	55.75	13.77	61.98	15.05
Structural ITM	62	54.53	15.21	63.15	17.33
Males	**186**	**53.76**	**14.44**	**61.00**	**16.19**
Guided ITM	51	55.27	14.71	65.94	16.38
Unguided ITM	54	52.89	14.41	59.98	15.91
Structural ITM	52	51.29	13.88	63.06	15.50
Females	**157**	**53.15**	**14.33**	**62.99**	**15.93**

Table 1 above displayed the Mean Achievement Scores of male and female students that were taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM). Table 1 revealed that the pretest mean achievement score of male students that were taught Trigonometry using Inquiry Teaching Method (ITM) was 53.76 with a standard deviation of 14.44 while the pretest mean achievement score of female students that were taught Trigonometry using Inquiry Teaching Method (ITM) was 53.15

with a standard deviation of 14.33. The posttest mean achievement score of male students that were taught Trigonometry using Inquiry Teaching Method (ITM)was 61.00 and a standard deviation of 16.19 while the posttest mean achievement score of female students that were taught Trigonometry using Inquiry Teaching Method (ITM) was 62.99 and a standard deviation of 15.93.

Table 1 revealed that at pretest, the male and female students that were taught Trigonometry using Inquiry Teaching Method (ITM) had equivalent mean achievement score but at posttest, the female students that were taught Trigonometry using Inquiry Teaching Method (ITM) had higher mean achievement score with a smaller standard deviation which means that the mean achievement score is homogenous.

Research Question 2: What are the mean interest scores of male and female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM) (ITM)?

Table 2: <u>The Mean Interest Scores of Male and Female students that are taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM)</u>

Gender	Number	Pretest		Post-test	
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)
Guided ITM	60	2.14	0.59	2.28	0.61
Unguided ITM	64	2.31	0.54	2.42	0.56
Structural ITM	62	2.13	0.55	2.32	0.59
Males	**186**	**2.19**	**0.56**	**2.34**	**0.59**
Guided ITM	51	2.18	0.59	2.57	0.62
Unguided ITM	54	2.21	0.60	2.51	0.62
Structural ITM	52	2.30	0.63	2.69	0.68
Females	**157**	**2.23**	**0.61**	**2.59**	**0.64**

Table 2 above displayed the Mean Interest Scores of male and female students that were taught Trigonometry using guided, unguided and structural Inquiry Teaching Method (ITM). Table 2 revealed that the pretest mean interest score of male students that were taught Trigonometry using Inquiry Teaching Method (ITM) was 2.19 with a standard deviation of 0.56 while the pretest mean interest score of female students that were taught Trigonometry using Inquiry Teaching Method (ITM)was 2.23 with a standard deviation of 0.61. The posttest mean interest score of male students that were taught Trigonometry using Inquiry Teaching Method (ITM)was 2.34 and a standard deviation of 0.59, the posttest interest mean score of female students that were taught Trigonometry using Inquiry Teaching Method (ITM)was 2.59 and a standard deviation of 0.64.

Table 2 revealed that both at pretest and posttest, the female students that were taught Trigonometry using Inquiry Teaching Method (ITM)had higher mean interest scores

with higher standard deviation which means that the mean interest scores are not homogenous.

Analyses of the Research Hypotheses

The four (4) null hypotheses were tested at 0.05 level of significance using ANCOVA. Tables 3 and 4 below showed the Analysis of Covariance (ANCOVA) on the Mean Achievement and Interest Scores of Students respectively, which are used for testing the null hypotheses.

Table 4: Analysis of Covariance (ANCOVA) on the Mean Achievement Scores of Students

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	118244.934[a]	8	14780.617	7349.113	.000	
Intercept	146.116	1	146.116	72.651	.000	
Preachievement	112210.420	1	112210.420	55792.466	.000	
GROUPS	2120.605	3	706.868	351.464	.000	
GENDER	739.042	1	739.042	367.461	.007	S
GROUPS * GENDER	102.730	3	34.243	17.026	.000	S
Error	899.011	447	2.011			
Total	1783019.000	456				
Corrected Total	119143.945	455				

a. R Squared = .992 (Adjusted R Squared = .992)

Table 3 above showed the Analysis of Covariance (ANCOVA) on the Mean Achievement Scores of male and female Students. The Table 3 is used to answer null hypotheses 1 and 2.

H0 1: There is no significant difference between the mean achievement scores of male and female students that are taught Trigonometry using Inquiry Teaching Method (ITM).

From the result of ANCOVA in table 3, it was observed that Group which was the main effect gave an f-value of 367.461 and was significant at 0.007. Since 0.007 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 1 was rejected. Hence, the study concluded that there was significant difference between

the mean achievement scores of male and female students that were taught Trigonometry using Inquiry Teaching Method (ITM).

H0 2: There is no significant interaction between gender of students and the methods on students' achievement scores in Trigonometry.

From the result of ANCOVA in table 3, it was observed that Group*Gender which gave an f-value of 17.026 and was significant at 0.000. Since 0.000 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 2 was rejected. Hence, the study concluded that there was significant interaction between gender of students and the method on students' achievement scores in Trigonometry.

Table 4: Analysis of Covariance (ANCOVA) on the Mean Interest Scores of Students

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	171.351[a]	8	21.419	3574.001	.000	
Intercept	.605	1	.605	100.970	.000	
PreInterest	163.697	1	163.697	27314.773	.000	
GROUPS	1.616	3	.539	89.855	.000	
GENDER	4.495	1	4.495	749.967	.000	S
GROUPS * GENDER	.094	3	.031	5.251	.001	S
Error	2.679	447	.006			
Total	2882.195	456				
Corrected Total	174.030	455				

a. R Squared = .985 (Adjusted R Squared = .984)

Table 4 above showed the Analysis of Covariance (ANCOVA) on the Mean Interest Scores of male and female Students. Table 4 is used for testing of null hypotheses 3 and 4.

H0 3: There is no significant difference between the mean interest scores of male and female students that are taught Trigonometry using Inquiry Teaching Method (ITM).

From the result of ANCOVA in table 4, it was observed that Gender gave an f-value of 749.967 and was significant at 0.000. Since 0.000 was less than 0.05, this meant that at

0.05 level, the f-value was significant. Therefore, hypothesis 3 was rejected. Hence, the study concluded that there was significant difference between the mean interest scores of male and female students that were taught Trigonometry using Inquiry Teaching Method (ITM).

H0 4: There is no significant interaction between gender of students and the method on students' interest scores in Trigonometry.

From the result of ANCOVA in table 4, it was observed that Group*Gender gave an f-value of 5.251 and was significant at 0.001. Since 0.001 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 4 was rejected. Hence, the study concluded that there was significant interaction between gender of students and the method on students' interest scores in Trigonometry.

Major Findings

The study discovered the followings:

1. The female students that taught trigonometry using the Inquiry Teaching Method (ITM)had the higher posttest mean achievement and interest scores than their male counterparts and the differences were significant.
2. There were significant interactions between gender of students and the methods on students' achievement and interest scores in Trigonometry.

Discussion of Findings

The study determined differentials in students' achievement and interest in trigonometry using Inquiry Teaching Method (ITM). The study was guided by two (2) research questions and four (4) research hypotheses. The study discovered that the female students that taught trigonometry using the Inquiry Teaching Method (ITM) had the higher posttest mean achievement and interest scores than their male counterparts and the differences were significant. This finding tallied with the assertions of Asoegwu (2008), Ahmed (2008) and Hydea&Mertzb (2009). Hydea and Mertzb (2009) observed that females have reached parity with male. Asoegwu (2008) revealed that female students achieved better in mathematics when they were taught using effective modern instructional approaches. According to Ahmed (2008), the females are more prone to express interest in mathematics than their male counterparts.

Secondly, the study discovered that there were significant interactions between gender of students and the method on students' achievement and interest scores in Trigonometry. The finding of this study is in contrary agreement with Abonyi (1998) and IIoputaife (2001) who found no interaction effect between gender and instructional model. However, the finding of the study agreed with assertions of Eze (1992) and Ezeudu (1995). The achievement of male and female students may vary due to variation in the instructional models, especially with the Inquiry Teaching Method (ITM) which are activity oriented and make the female students to be more prone than their male

counterparts to learn at their own rate, offering the female students more unique opportunity to read, work, accept and internalize the Trigonometric concepts at their own pace, master the subject as indicated by the accuracy of their own responses. The approach equally allows both male and female students (particularly more for the female students) the knowledge of immediate feedback which serves as a great motivation propelling female learners to want to learn more. This is because it is the female students that do domestic chores more than their male counterparts and mathematics plays a significant role in domestic chores, so it won't be difficult for the female students to transcend their passive mathematical domestic knowledge to active mathematical classroom knowledge since that, according to Aniaku (2012), Inquiry Teaching Method (ITM) encourages students to apply scientific process, which they have previously learnt to explore and construct meaningful knowledge and skills. So, it won't be difficult for the female students to achieve better and show more interest than their male counterparts in Trigonometry.

Recommendations

Considering the findings in this study, the following recommendations are made:

1. Parents and mathematics teachers should ensure that the male students are given equal functions with their female counterparts both at home and in school to do so that it won't be difficult for the male students to transfer the knowledge learnt at home to school Mathematics (trigonometry).
2. Mathematics teachers should not ignore the female students in the act of teaching Trigonometry.
3. Government, through the State and Federal ministries of education should encourage female students more to learn mathematics and should organize workshops and conferences for teachers and parents on the need to use Structured Inquiry Teaching Method (ITM) on their female students.
4. Government, through the State and Federal ministries of education should encourage the Mathematics textbook writers to write and publish Mathematics textbooks based on the Structured Inquiry Teaching Method (ITM).

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